

# **MINX Document 3**

## **MINX – Overview and Plume Case Studies**



**David Nelson**

**Raytheon Company, Jet Propulsion Laboratory,  
California Institute of Technology**

**May, 2012**



**Copyright 2012 California Institute of Technology.  
Government sponsorship acknowledged.**

# **Contents**

**Scientific motivation for MINX**

**MISR Plume Project website**

**Animations and interpretations with MINX**

- **Smoke plume over Alaska**
- **Dust in Taklamakan Basin**
- **Volcanic ash over Chile**
- **Snow storm in Antarctica**

# **Contents**

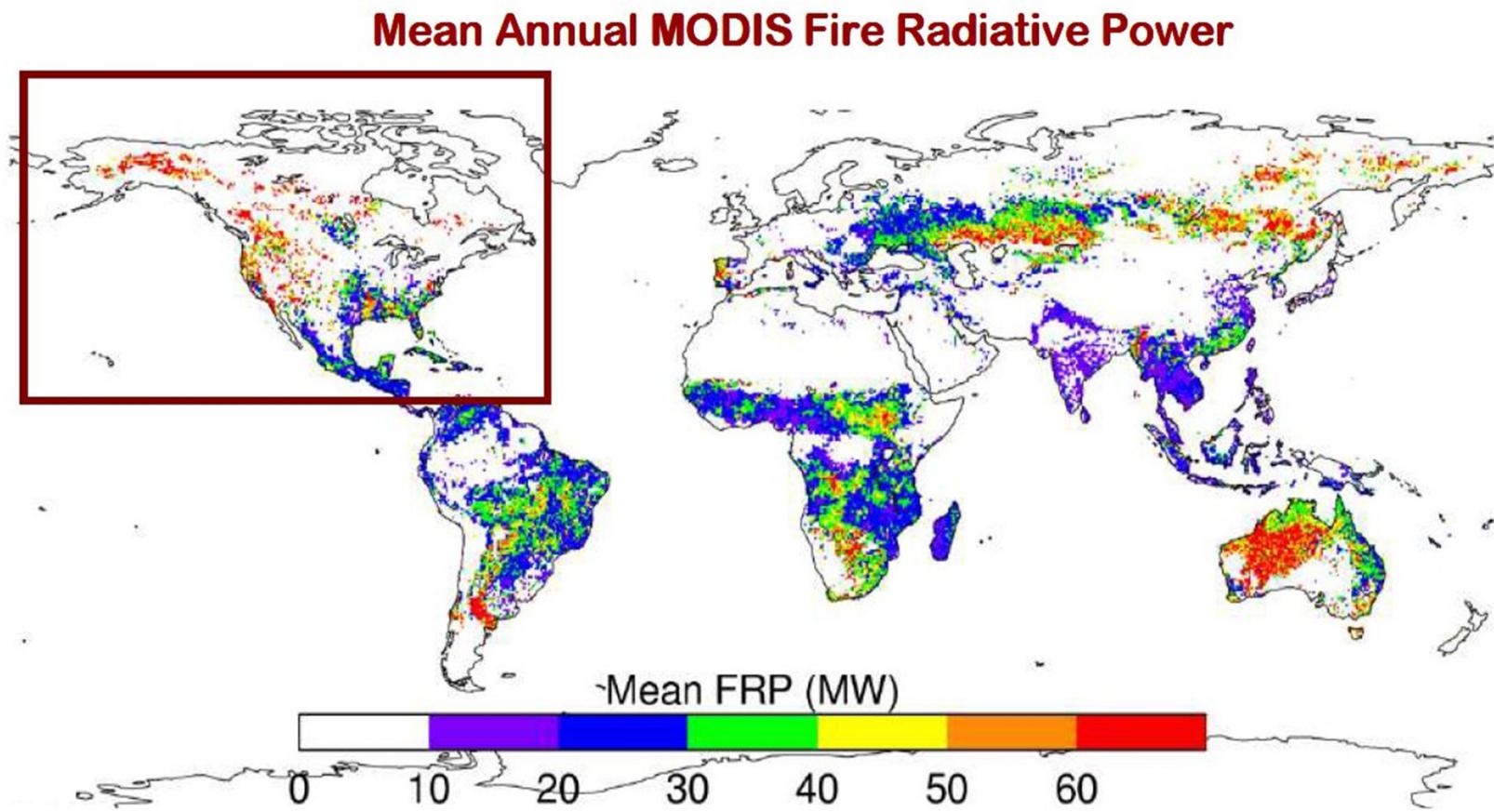
**Scientific motivation for MINX**

**MISR Plume Project website**

**Animations and interpretations with MINX**

- **Smoke plume over Alaska**
- **Dust in Taklamakan Basin**
- **Volcanic ash over Chile**
- **Snow storm in Antarctica**

# Fires are a world-wide complex phenomenon



[Giglio et al., 2006]

Courtesy of Maria Val Martin

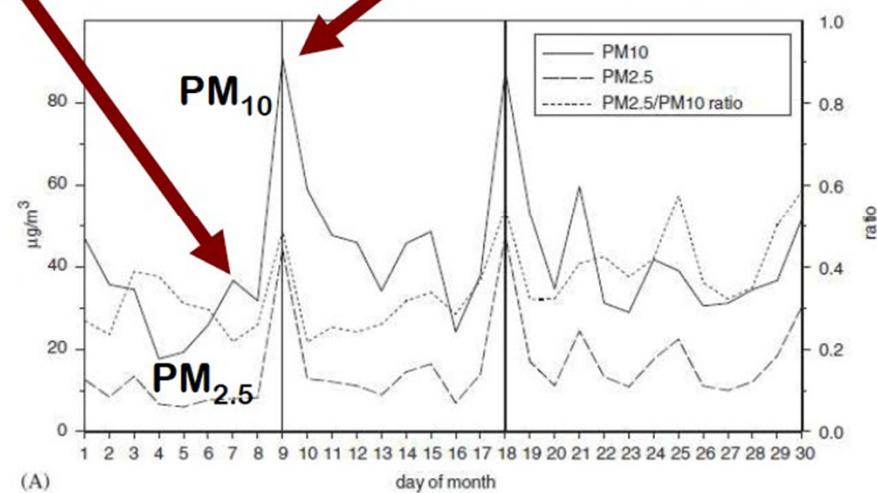
# Fire impacts regional air quality

June 2002 Hayman Fire over Colorado caused worst air quality ever in Denver



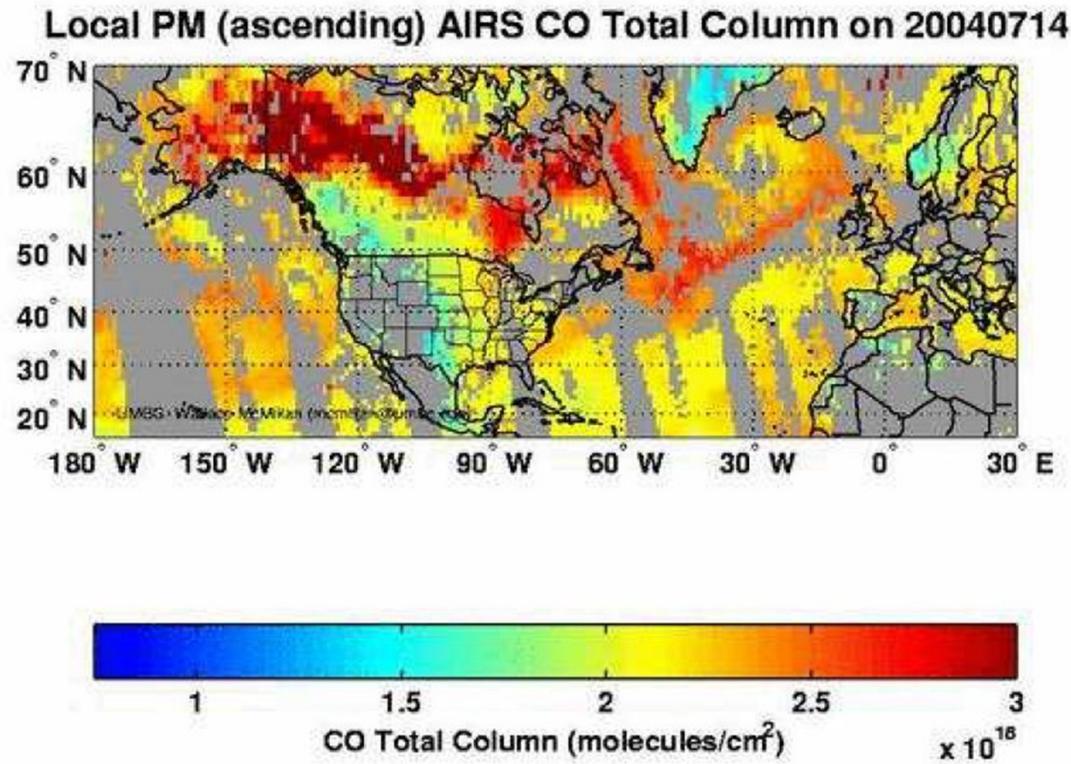
Daily mean  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$  in June

[Vedal et al., 2006]



Courtesy of Maria Val Martin

# Long-range transport of fire emissions



2004 Alaska fire emissions reached southern U.S. and Europe!!

[e.g., *Val Martin et al., 2006; Real et al., 2007; Duck et al., 2007*]

[http://asl.umbc.edu/pub/mcmillan/www/index\\_INTEXA.html](http://asl.umbc.edu/pub/mcmillan/www/index_INTEXA.html)

Courtesy of Maria Val Martin

## Scientific Motivation for MINX

- In 2005, the EPA (Environmental Protection Agency) and NASA funded a proposal to develop an **aerosol injection height climatology** in support of studying forest fires, climate change and air quality.
  - Team scientists: Jennifer Logan (PI – Harvard), David Diner and Dominic Mazzoni (NASA-JPL), Ralph Kahn (NASA-GSFC)
- “The elevation at which aerosols are injected into the atmosphere has a strong influence on how the smoke is dispersed, and is a key input to aerosol transport models.” (Kahn, et al, 2008)
- Aerosols that rise into the free troposphere can remain aloft longer and be transported farther than those that remain in the boundary layer.
  - **Smoke** can warm the atmosphere and enhance melting of snow and ice
  - **Dust** may carry pathogens
  - **Volcanic eruptions** can affect global transportation

# **Contents**

**Scientific motivation for MINX**

**MISR Plume Project website**

**Animations and interpretations with MINX**

- **Smoke plume over Alaska**
- **Dust in Taklamakan Basin**
- **Volcanic ash over Chile**
- **Snow storm in Antarctica**

# Plume Project Website - 2

<http://misr.jpl.nasa.gov/getData/accessData/MisrMinxPlumes/>

**MISR Plume Height Project**  
David Nelson, Cecelia Lawshe, Dominic Mazzoni, David Diner, Ralph Kahn

March, 2012 - see what's changed

Wildfire smoke plumes   Volcanic plumes

(click Project Areas to expand or collapse)

Project Area (Top Level)	Project Area (Secondary Level)	Date Added to Website	Images and Data
Africa	0 to 20 North, 2005 0 to 20 North, 2006	09/09/2009 09/09/2009	<a href="#">View/Download</a> <a href="#">View/Download</a>
Alaska Summer 2009			
ARCTAS Canada 2008			
Indonesia			
North America	2001 2002 2003 2004 2005 2006 2007 2008	03/05/2012 09/21/2007 03/05/2012 03/16/2009 08/06/2008 05/19/2008 08/06/2008 03/05/2012	<a href="#">View/Download</a> <a href="#">View/Download</a> <a href="#">View/Download</a> <a href="#">View/Download</a> <a href="#">View/Download</a> <a href="#">View/Download</a> <a href="#">View/Download</a> <a href="#">View/Download</a>
Siberia			
South America	Amazon Aug-Sept 2006 Amazon Aug-Sept 2007 Boliv-Parag Aug-Sept 2006 Boliv-Parag Aug-Sept 2007	03/05/2012 03/05/2012 03/05/2012 03/05/2012	<a href="#">View/Download</a> <a href="#">View/Download</a> <a href="#">View/Download</a> <a href="#">View/Download</a>
Southeast Asia			

Useful links:

- Product Description
- Product Labeling, Terms Used, and File Formats
- Data Quality Statement and Error Analysis
- Related Publications
- MISR
- MODIS

**Project Area**

**MISR Plume Height Project**  
**South America Amazon Aug-Sept 2007**  
[Home Page](#)

Created using the MINX software and ColdFusion  
David Nelson, Cecelia Lawshe, Dominic Mazzoni, David Diner, Ralph Kahn

Date Plumes Processed: 03/05/2012  
Number of orbits with plumes: 36  
Number of plumes processed: 594  
Number of plumes w/ wind-corr hts: 594  
Number of plumes w/ power estimate: 579  
Number of plumes w/ hts and power: 579  
Total area of plumes: 95113 sq km  
Total radiative power of plumes: 307354 MW  
Median value of median plume top hts: 975 meters ASL  
Median value of maximum plume top hts: 1253 meters ASL  
Median # of data points/plume: 80  
Median # of best-wind hts/plume: 34

[View Plume Statistics by Time Interval](#)  
[View and Retrieve Project Summary Files](#)  
[View, Sort and Retrieve Raw Data Files](#)

Orbits/Block Ranges	Date Acquired	# Plumes
040560 - B95-102	08/03/2007	8
040574 - B95-101	08/04/2007	16
040589 - B96-101	08/05/2007	10
040618 - B95-102	08/07/2007	16
040662 - B98-101	08/10/2007	2
040691 - B95-101	08/12/2007	12
040720 - B95-102	08/14/2007	20
040749 - B95-100	08/16/2007	15
040778 - B96-102	08/18/2007	35
040793 - B95-101	08/19/2007	20
040807 - B93-102	08/20/2007	29
040822 - B96-102	08/21/2007	18
040851 - B97-102	08/23/2007	21
040895 - B98-101	08/26/2007	4
040909 - B97-100	08/27/2007	20

We gratefully acknowledge support from NASA and the EPA for this work. We also acknowledge contributions by the NASA Langley Atmospheric Science Data Center and Raytheon Company

# Plume Project Website - 3

**Plume Page**

**MISR Plume Height Project**



**South America  
Amazon Aug-Sept 2007**

[Home Page](#) - [Project Area](#)

Region Name	Region Type	Height ASL (km)	Direction (deg CW from N)	Total Power (MW)
040778 - B96 - SPWB1	Smoke Plume	1.69	286.0	99999.0
040778 - B96 - SPWB2	Smoke Plume	1.82	277.0	99999.0
040778 - B96 - SPWB3	Smoke Plume	0.95	293.0	99999.0
040778 - B96 - SPWB4	Smoke Plume	0.98	285.0	99999.0
040778 - B96 - SPWB5	Smoke Plume	1.39	281.0	99999.0
040778 - B97 - SPNB1	Smoke Cloud	1.85	99999.0	99999.0
040778 - B97 - SPWB1	Smoke Plume	1.13	287.0	1024.0
040778 - B97 - SPWB2	Smoke Plume	0.95	291.0	74.0
040778 - B97 - SPWB3	Smoke Plume	0.94	299.0	1161.0
040778 - B97 - SPWR1	Smoke Plume	1.27	295.0	1268.0
040778 - B97 - SPWR2	Smoke Plume	1.63	280.0	9092.0
040778 - B97 - SPWR4	Smoke Plume	1.68	272.0	1138.0
040778 - B98 - SPWB1	Smoke Plume	1.02	297.0	53.0
040778 - B98 - SPWB2	Smoke Plume	1.66	292.0	2076.0
040778 - B98 - SPWR1	Smoke Plume	0.88	291.0	751.0
040778 - B98 - SPWR2	Smoke Plume	1.24	268.0	2926.0
040778 - B98 - SPWR3	Smoke Plume	0.83	294.0	1439.0
040778 - B98 - SPWR4	Smoke Plume	1.42	283.0	1742.0
040778 - B98 - SPWR5	Smoke Plume	1.21	291.0	1094.0
040778 - B99 - SPNB1	Smoke Cloud	2.09	99999.0	99999.0
040778 - B99 - SPWB1	Smoke Plume	1.51	296.0	739.0
040778 - B99 - SPWB2	Smoke Plume	1.1	295.0	98.0
040778 - B100 - SPWB1	Smoke Plume	0.84	283.0	90.0
040778 - B100 - SPWB2	Smoke Plume	1.25	274.0	555.0

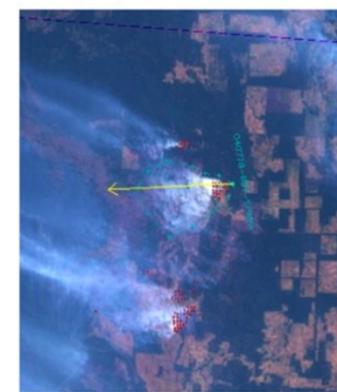
**MISR Plume Height Project: South America - Amazon Aug-Sept 2007 → Orbit 040778 - Block B97 → SPWR4**

[View/Download Raw Data](#)

◀ Previous Region      Next Region ▶

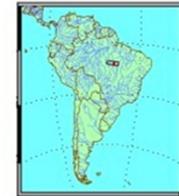
(Right-click any image and select "View Image" or "Copy Image" to view full-size or to save to your workplace.)

Nadir image w/ digitized region outline and name (cyan), wind direction (yellow) and MODIS fire pixels (red)



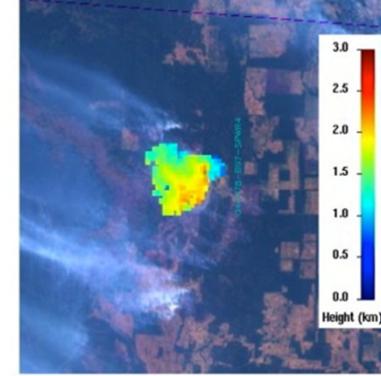
[View raw ASCII data for current plume](#)

Region Location in MISR block



MINX profiles and histograms are also archived on the website

Nadir Image w/ Color-Coded, Wind-Corrected Heights



Camera Animation of Region



To see the full-size mpeg animation, or if your browser does not play the animation, [right click this link](#).

# Plume Project Website - 4

## View, Sort and Retrieve Raw Data Files

**MISR Plume Height Project**

**Raw Data Files**

Home Page - Project Area Page

Created using the MINX software and ColdFusion  
David Nelson, Cecelia Lawshe, David Diner, Ralph Kahn

Advanced Search for South America - Amazon Aug-Sept 2007:  
Enter your search criteria below and click on the "Submit Advanced Search" button:

Type	<input checked="" type="radio"/> Smoke Plume	<input type="radio"/> Smoke Cloud			
Minimum	Date Acquired	Longitude	Latitude	Median Height ASL (km)	Total Power (MW)
Maximum					

Project Area: South America - Amazon Aug-Sept 2007  
Click on a header title to sort for that value. Then check all the files you want to download. Finally, click "Review File Selections" at the bottom to proceed.

Orbit	Block	Type/ Number	Date Acquired	Longitude	Latitude	Median Height ASL (km)	Direction (deg CW from N)	Total Power (MW)	Raw Data File	Download File
040560	95	SPNB1	08/03/2007	-62.092	-5.162	3.22	NA	NA	<a href="#">View</a>	<input type="checkbox"/>
040560	95	SPNB2	08/03/2007	-63.526	-5.874	1.15	NA	NA	<a href="#">View</a>	<input type="checkbox"/>
040560	97	SPWB1	08/03/2007	-61.388	-7.832	0.42	309.0	78.0	<a href="#">View</a>	<input type="checkbox"/>
040560	98	SPWB1	08/03/2007	-63.684	-9.318	0.61	306.0	64.0	<a href="#">View</a>	<input type="checkbox"/>
040560	98	SPWB2	08/03/2007	-62.494	-9.069	0.5	332.0	18.0	<a href="#">View</a>	<input type="checkbox"/>
040560	99	SPWB1	08/03/2007	-62.583	-10.194	0.62	314.0	60.0	<a href="#">View</a>	<input type="checkbox"/>
040560	100	SPWB1	08/03/2007	-65.061	-12.261	0.54	326.0	103.0	<a href="#">View</a>	<input type="checkbox"/>
040560	101	SPWB1	08/03/2007	-64.645	-13.435	0.64	294.0	43.0	<a href="#">View</a>	<input type="checkbox"/>
040560	102	SPWB1	08/03/2007	-63.676	-13.898	0.57	284.0	116.0	<a href="#">View</a>	<input type="checkbox"/>
040560	102	SPWB2	08/03/2007	-64.607	-14.767	0.53	308.0	110.0	<a href="#">View</a>	<input type="checkbox"/>
040574	95	SPWB1	08/04/2007	-50.068	-5.455	0.51	252.0	110.0	<a href="#">View</a>	<input type="checkbox"/>
040574	95	SPWB2	08/04/2007	-48.594	-6.193	0.52	297.0	37.0	<a href="#">View</a>	<input type="checkbox"/>
040574	96	SPWB1	08/04/2007	-50.515	-6.714	0.7	263.0	140.0	<a href="#">View</a>	<input type="checkbox"/>
040574	96	SPWB2	08/04/2007	-47.895	-6.511	0.67	286.0	82.0	<a href="#">View</a>	<input type="checkbox"/>

## Advanced search parameters

- Any or all raw plume text files for a project area can be selected for downloading
- You will receive an email with a “cURL” file and instructions for downloading
- You must have the “curl” app to retrieve the data – it’s standard with Macs – PC users can download a free copy

Click on column headers to sort

**MISR Plume Height Project**

**Raw Data Files**

Home Page - Project Area Page

Created using the MINX software and ColdFusion  
David Nelson, Cecelia Lawshe, David Diner, Ralph Kahn

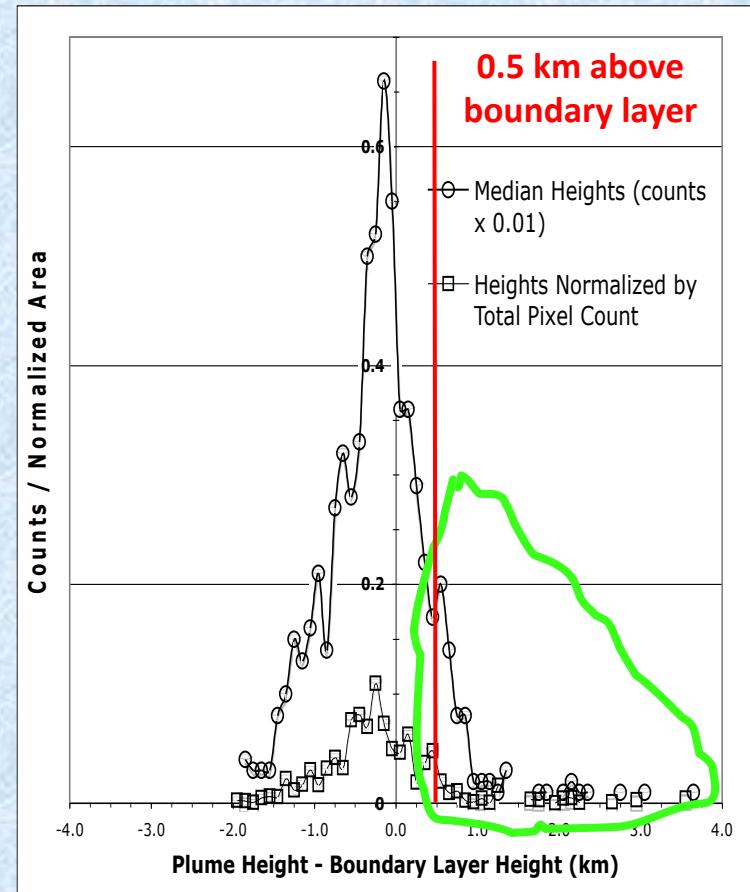
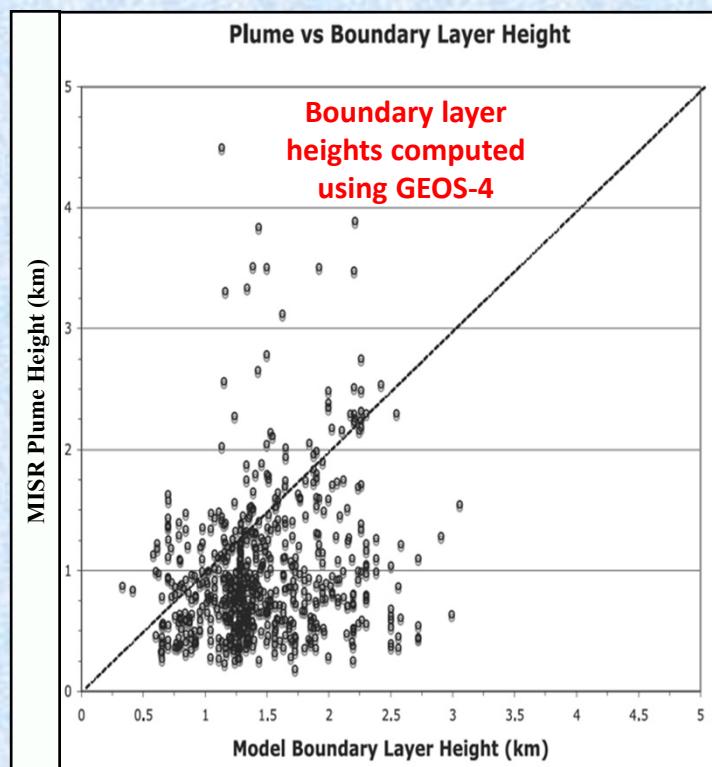
Project Area: South America - Amazon Aug-Sept 2007  
Enter your email address at bottom and click on "Email List of Selections" to receive a file containing the list of URLs corresponding to your selections.

Orbit	Block	Type/ Number	Date Acquired	Longitude	Latitude	Median Height ASL (km)	Direction (deg CW from N)	Total Power (MW)	Raw Data File
041346	100	SPWB4	09/26/2007	-56.321	-11.907	1.3	338.0	199.0	<a href="#">View</a>
041361	100	SPWR2	09/27/2007	-64.282	-12.107	1.04	70.0	750.0	<a href="#">View</a>
041361	101	SPWR5	09/27/2007	-67.485	-13.207	0.89	128.0	123.0	<a href="#">View</a>

Enter the email address where the URL file should be sent:

# Alaska-Yukon Fire Plume Statistics, Summer 2004

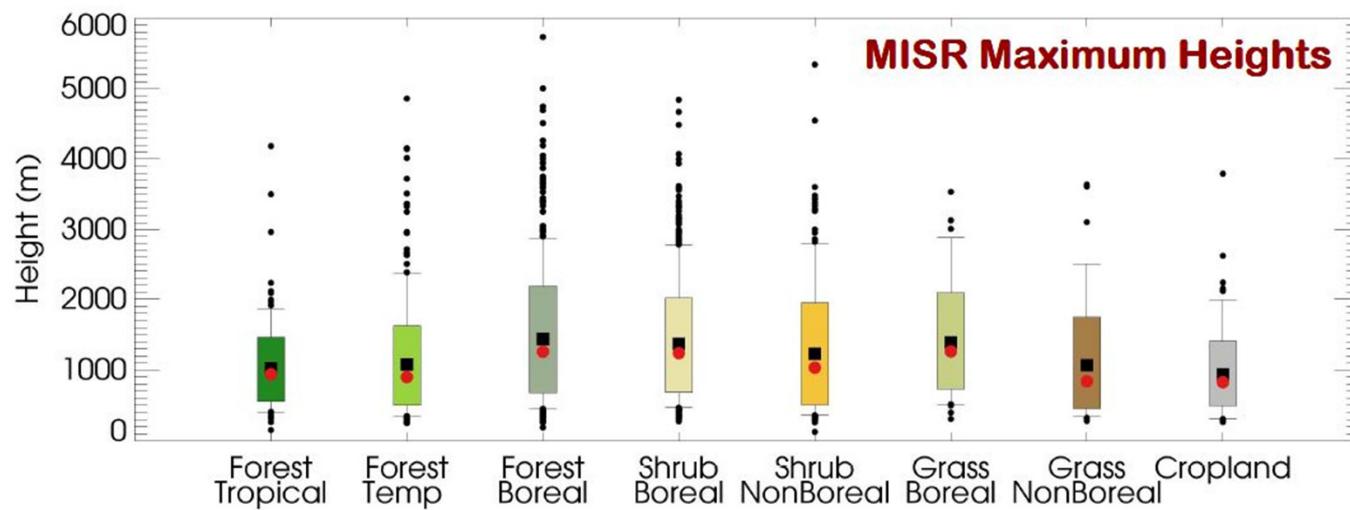
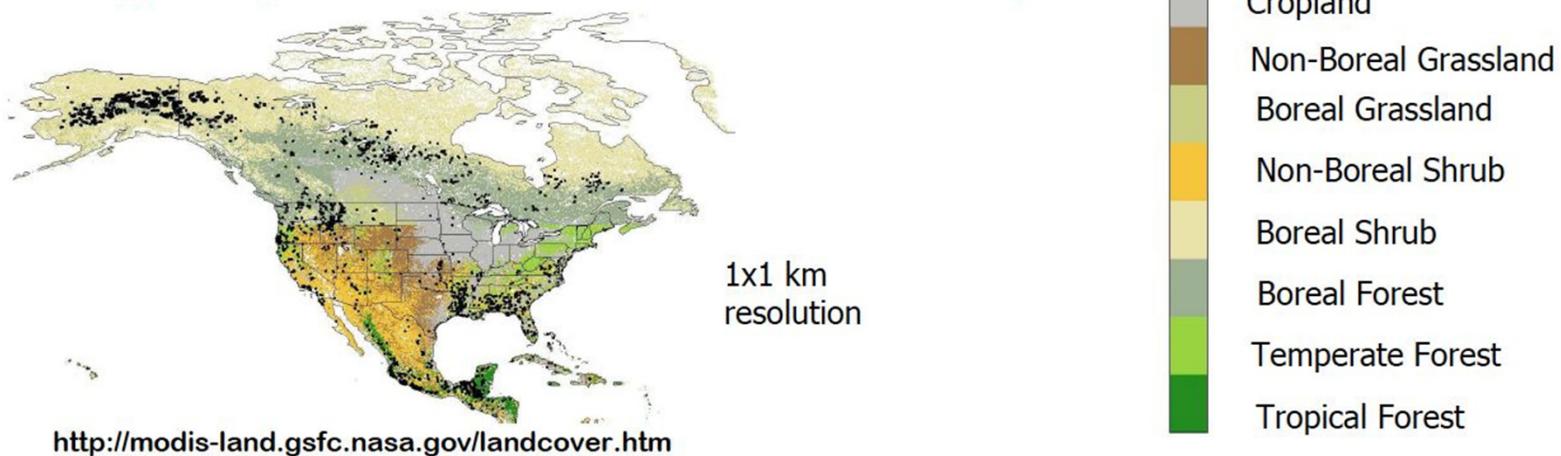
- MINX found that at least 10% of wildfire smoke plumes reached the free troposphere. CALIOP concluded this was very rare
- CALIOP's swath width is ~ 4000 times narrower than MISR's suggesting that poor horizontal sampling is responsible



First science results from Plume Website data  
R. Kahn, Y. Chen, D. Nelson et al., GRL 2008

# Large variability in vertical injection heights

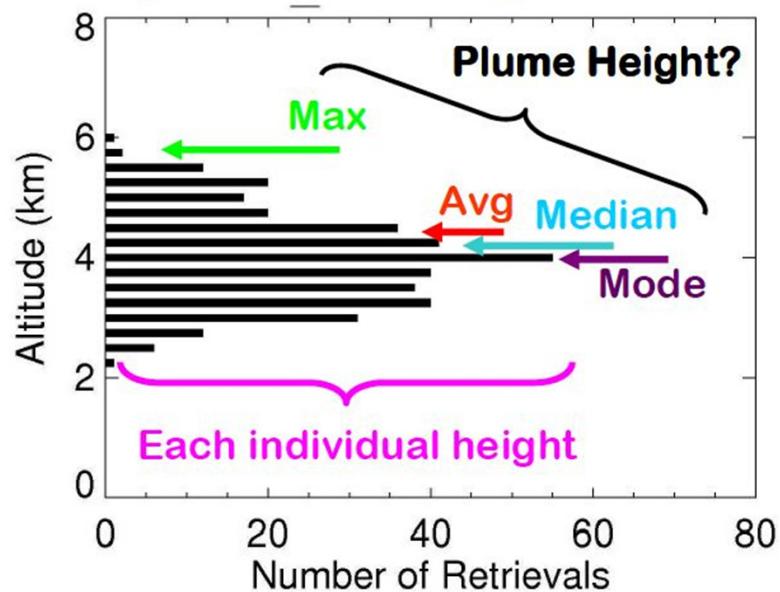
Ecological regions based on MODIS IGBP land cover map



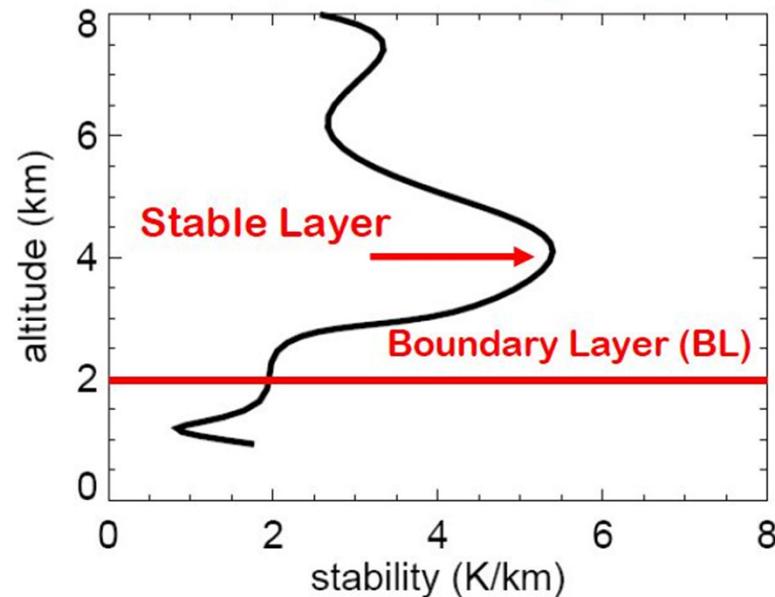
Courtesy of Maria Val Martin

# Plume distribution, atmospheric conditions and fire properties

Histogram of Plume Height Retrievals



Atmospheric Stability Profile



- Meteorological fields from GEOS
- Fire properties (size and power) from MODIS

$$\text{Stability} = \frac{d\vartheta}{dz}, \text{ where } \vartheta = T \left( \frac{P_0}{P} \right)^{R/c_p}$$

# **Contents**

**Scientific motivation for MINX**

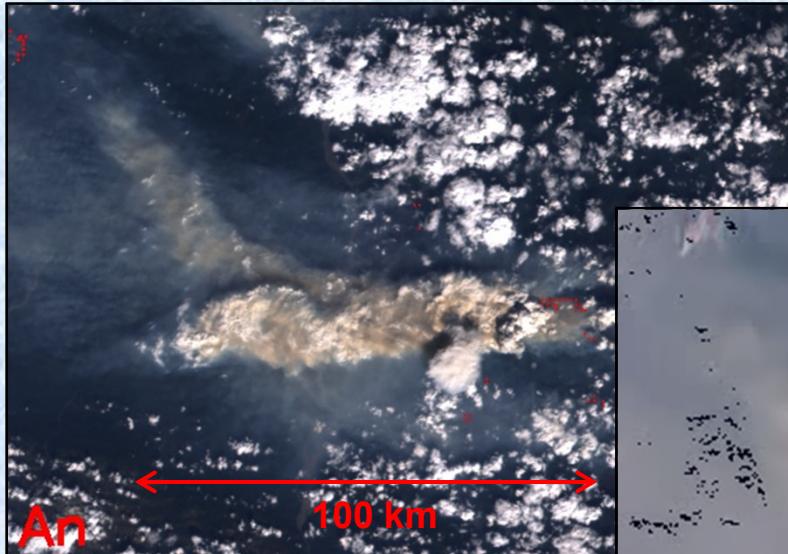
**MISR Plume Project website**

**Animations and interpretations with MINX**

- **Smoke plume over Alaska**
- **Dust in Taklamakan Basin**
- **Volcanic ash over Chile**
- **Snow storm in Antarctica**

# Smoke Plumes - Alaska, USA

## Orbit 24152, July 2, 2004



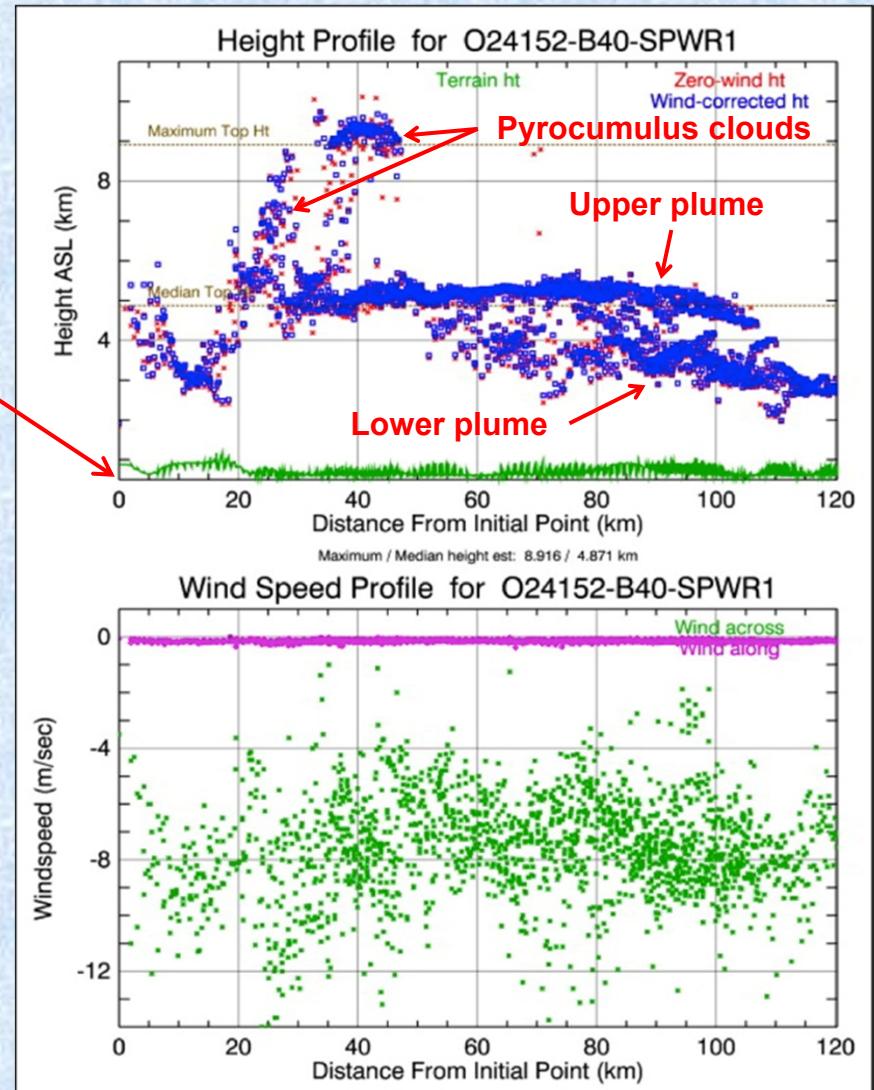
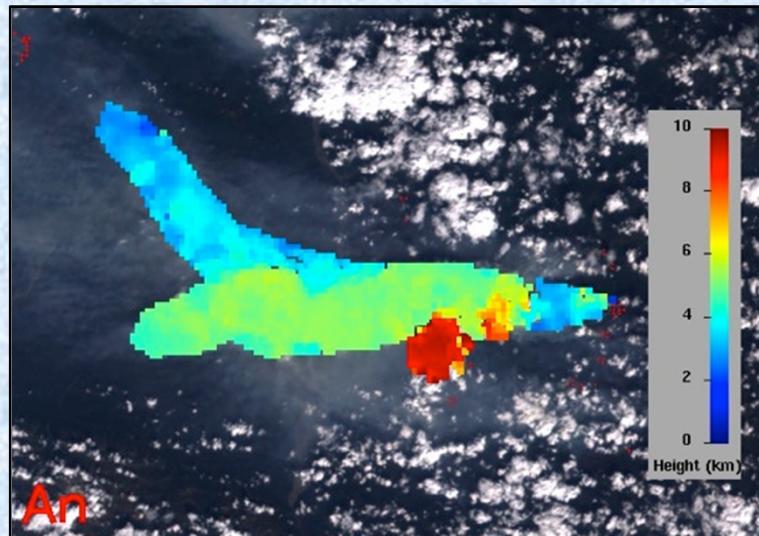
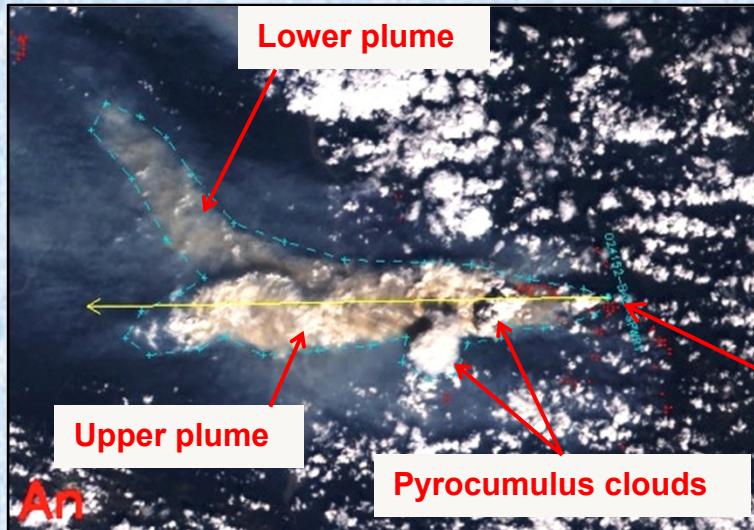
An image

Animation



Hover over window then  
click arrow to start movie

# Alaska Fire, July 2, 2004 (5054 MW)



# Contents

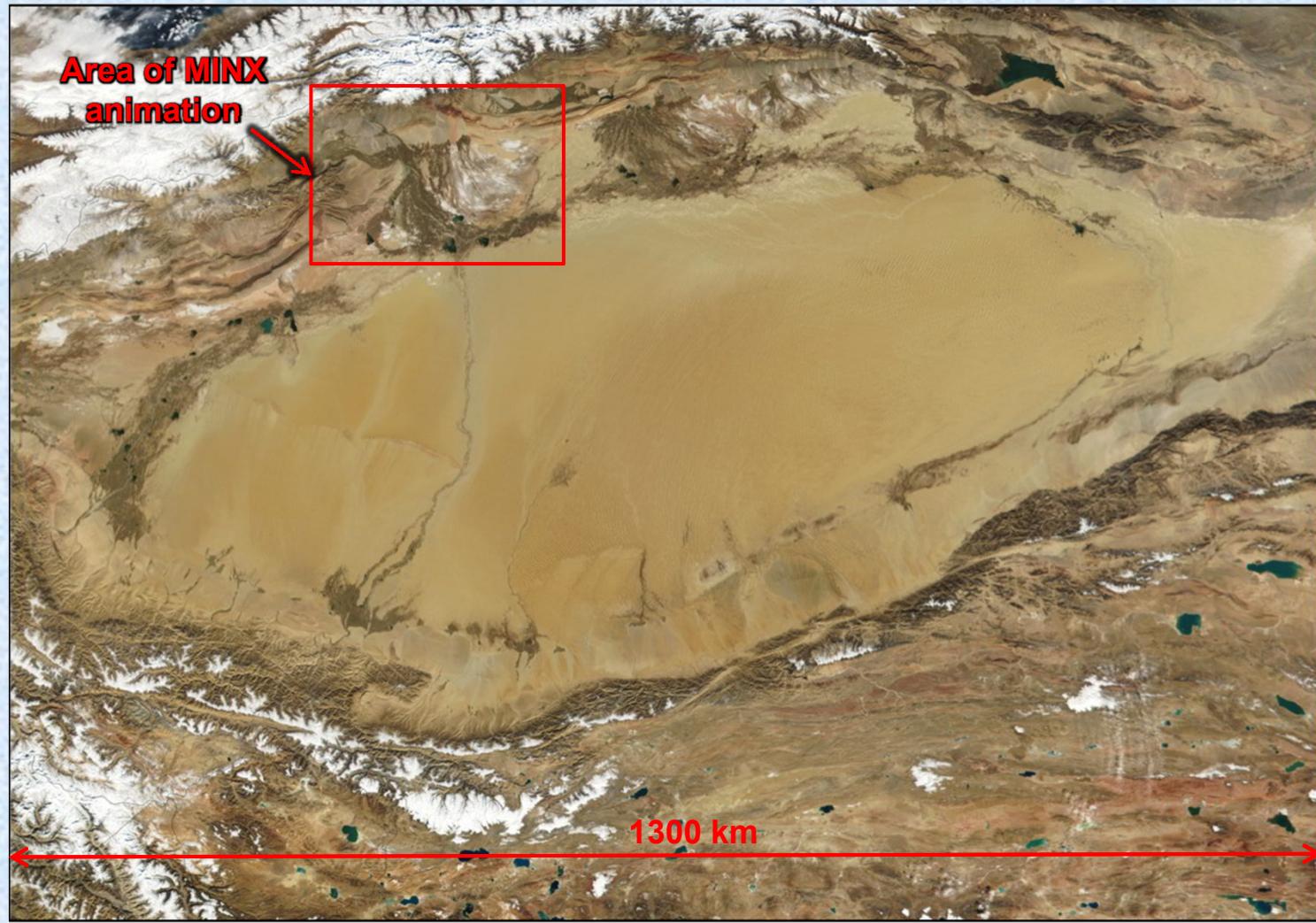
**Scientific motivation for MINX**

**MISR Plume Project website**

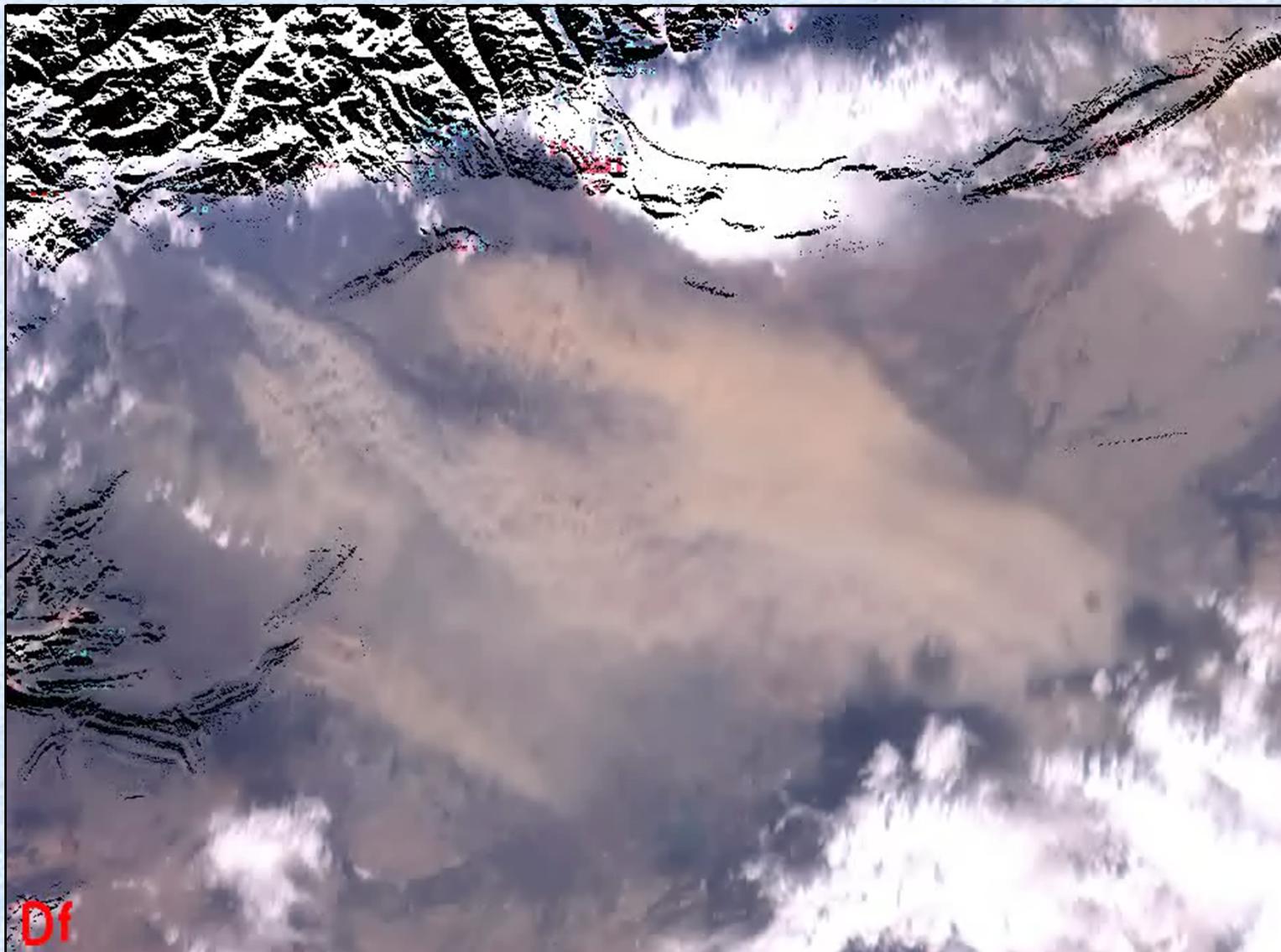
**Animations and interpretations with MINX**

- Smoke plume over Alaska
- **Dust in Taklamakan Basin**
- Volcanic ash over Chile
- Snow storm in Antarctica

# Dust Plumes - Taklamakan Desert in Tarim Basin North of Tibetan Plateau (MODIS Image)

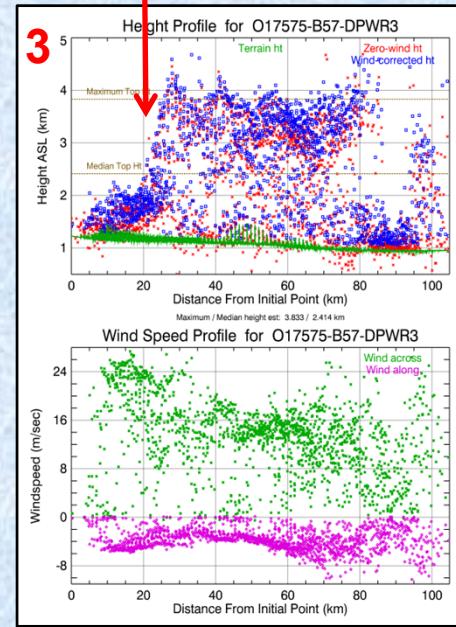
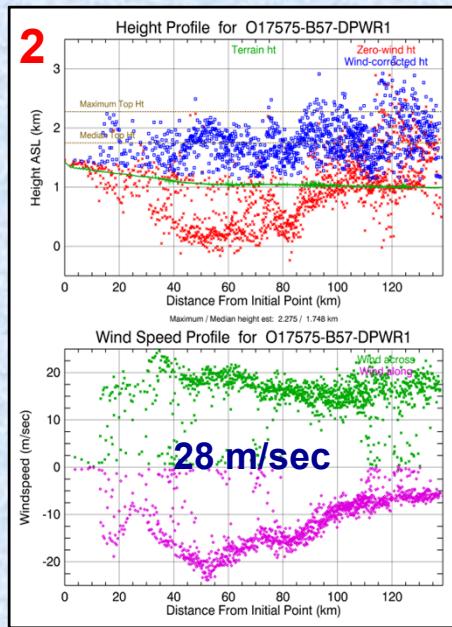
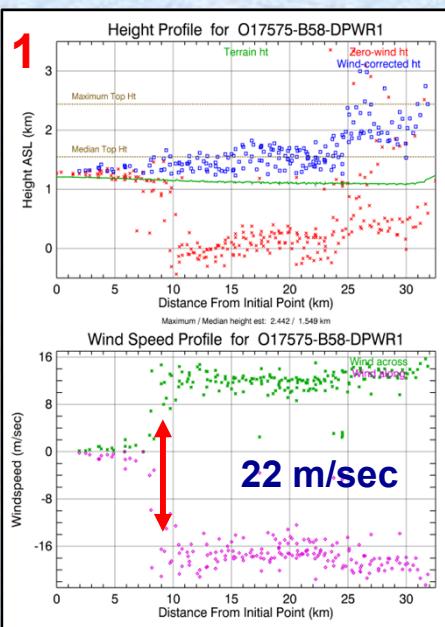
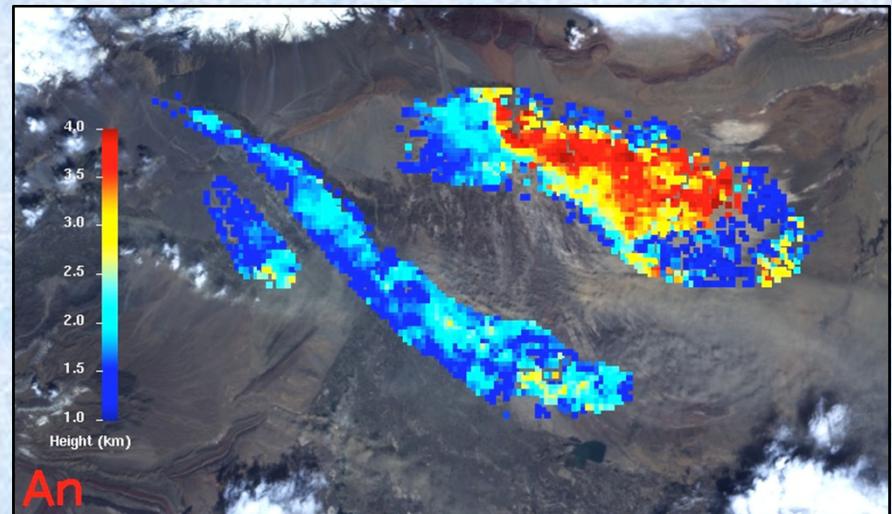
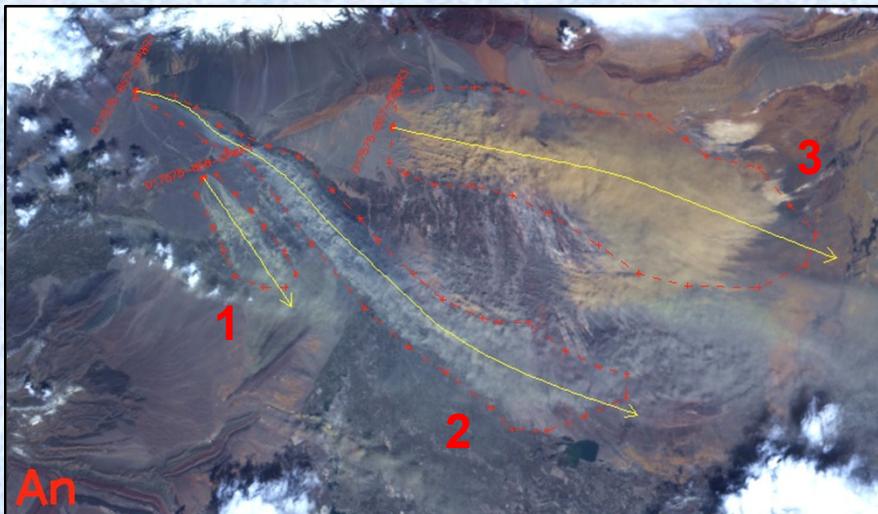


## Taklamakan Dust – Orbit 17575 – April 8, 2003



Hover over window then click arrow to start movie

# Taklamakan Dust – Orbit 17575 – April 8, 2003



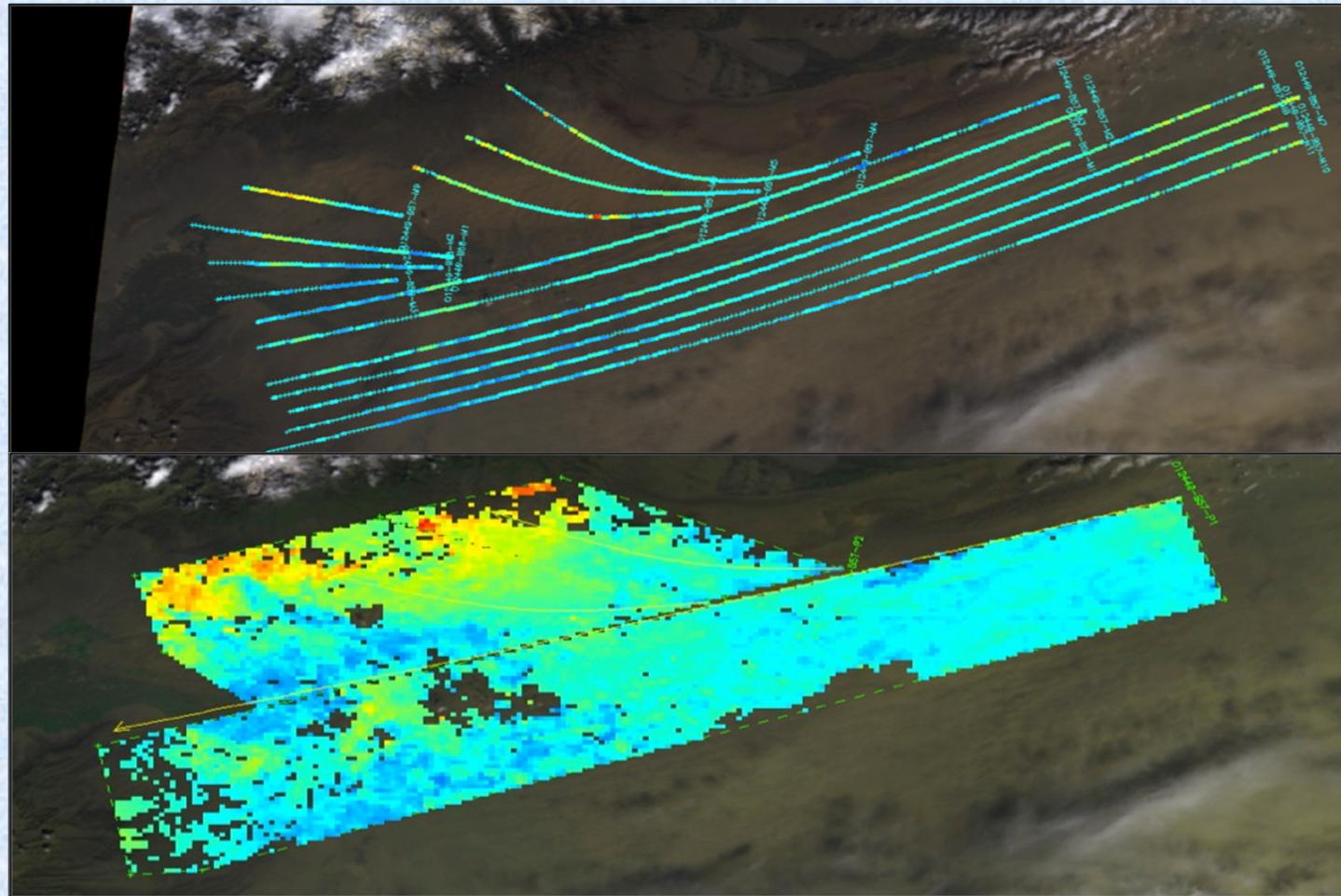
Several dust sources are linear  
- probably dry stream beds

Wind speed increases abruptly on plume 1

Dust rises about 3 km on plume 3

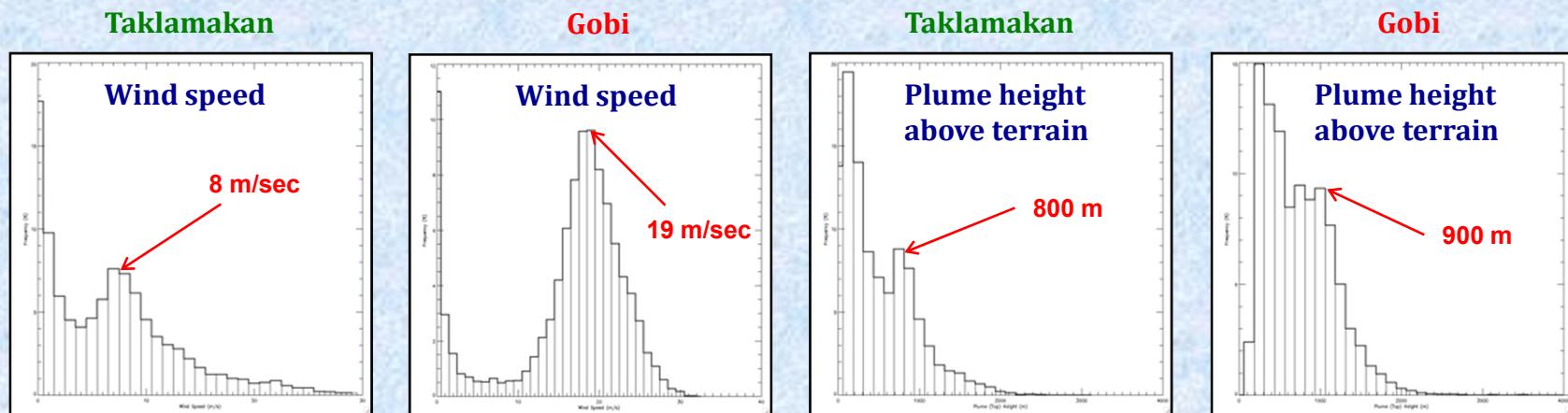
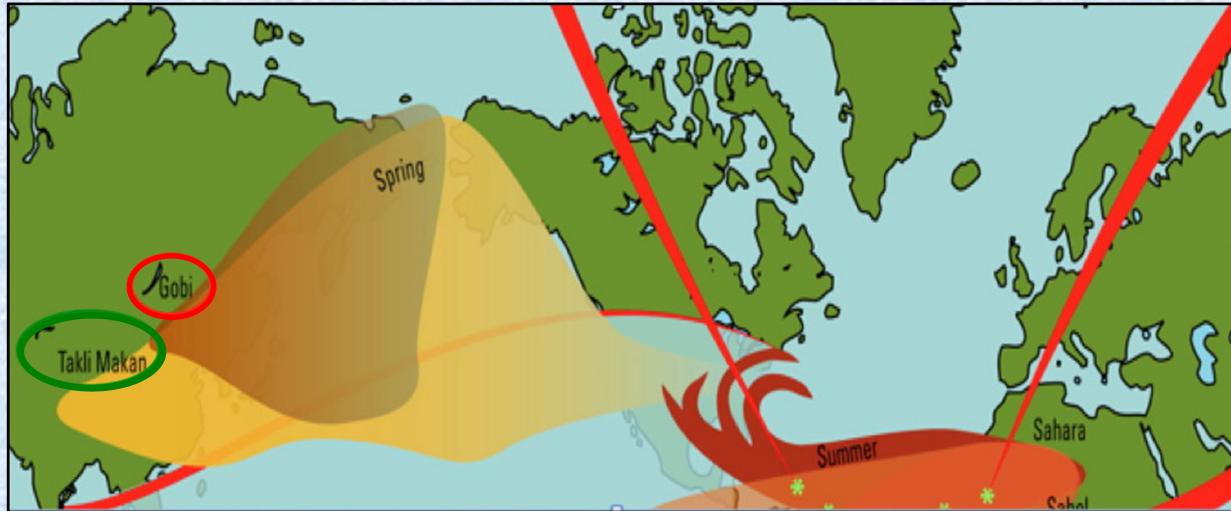
# Taklamakan Desert

## Digitizing Alternatives – Lines or Polygons



Courtesy of Michael Goetz, Olga Kalashnikova and Mike Garay, JPL, 2011

# Taklamakan vs Gobi Dust Plume Heights and Wind Speeds



Courtesy of Michael Goetz, Olga Kalashnikova and Mike Garay, JPL, 2011

# Contents

**Scientific motivation for MINX**

**MISR Plume Project website**

**Animations and interpretations with MINX**

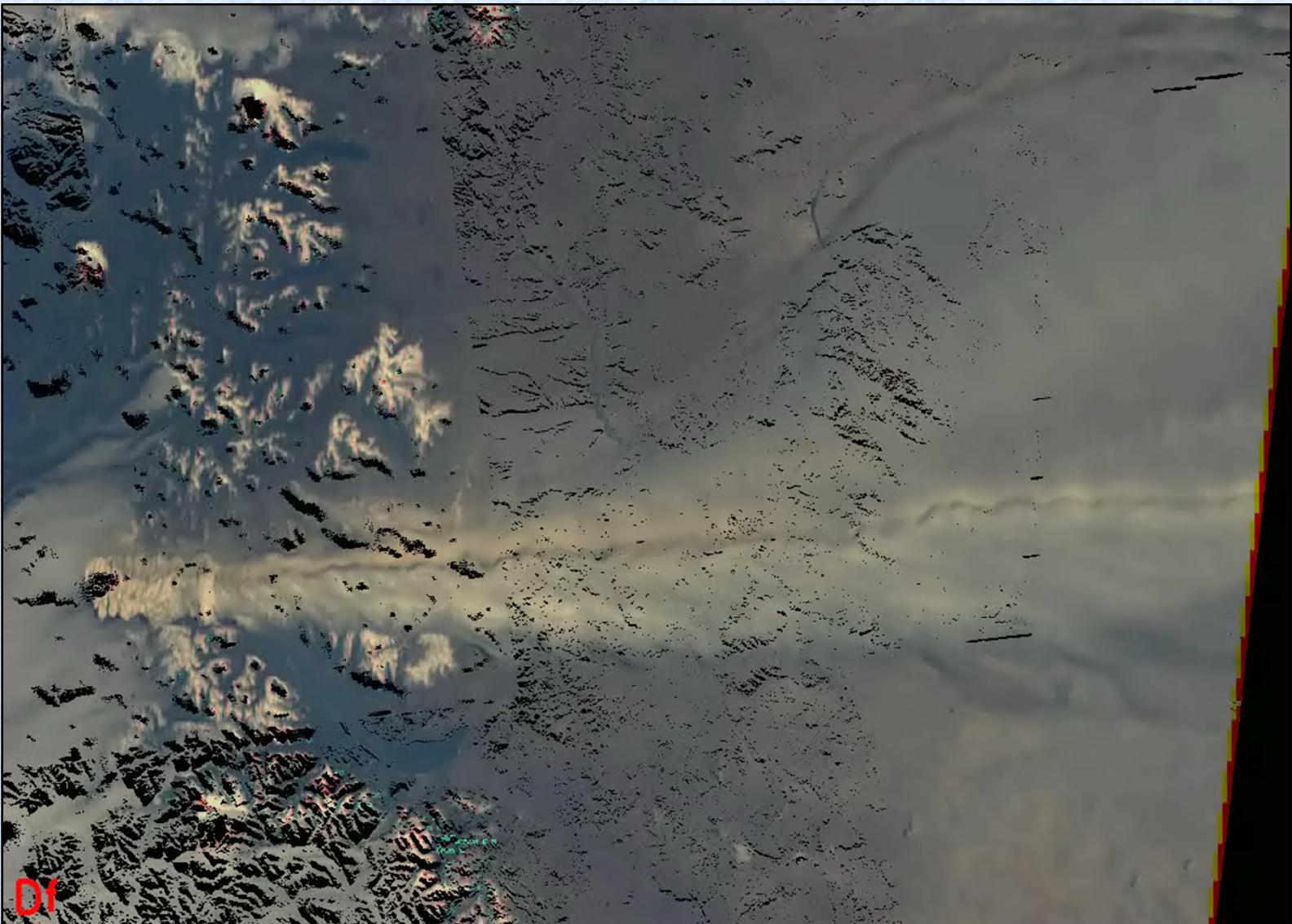
- **Smoke plume over Alaska**
- **Dust in Taklamakan Basin**
- **Volcanic ash over Chile**
- **Snow storm in Antarctica**

## Volcanic Plumes - Puyehue-Cordon, Chile - June, 2011



© Reuters

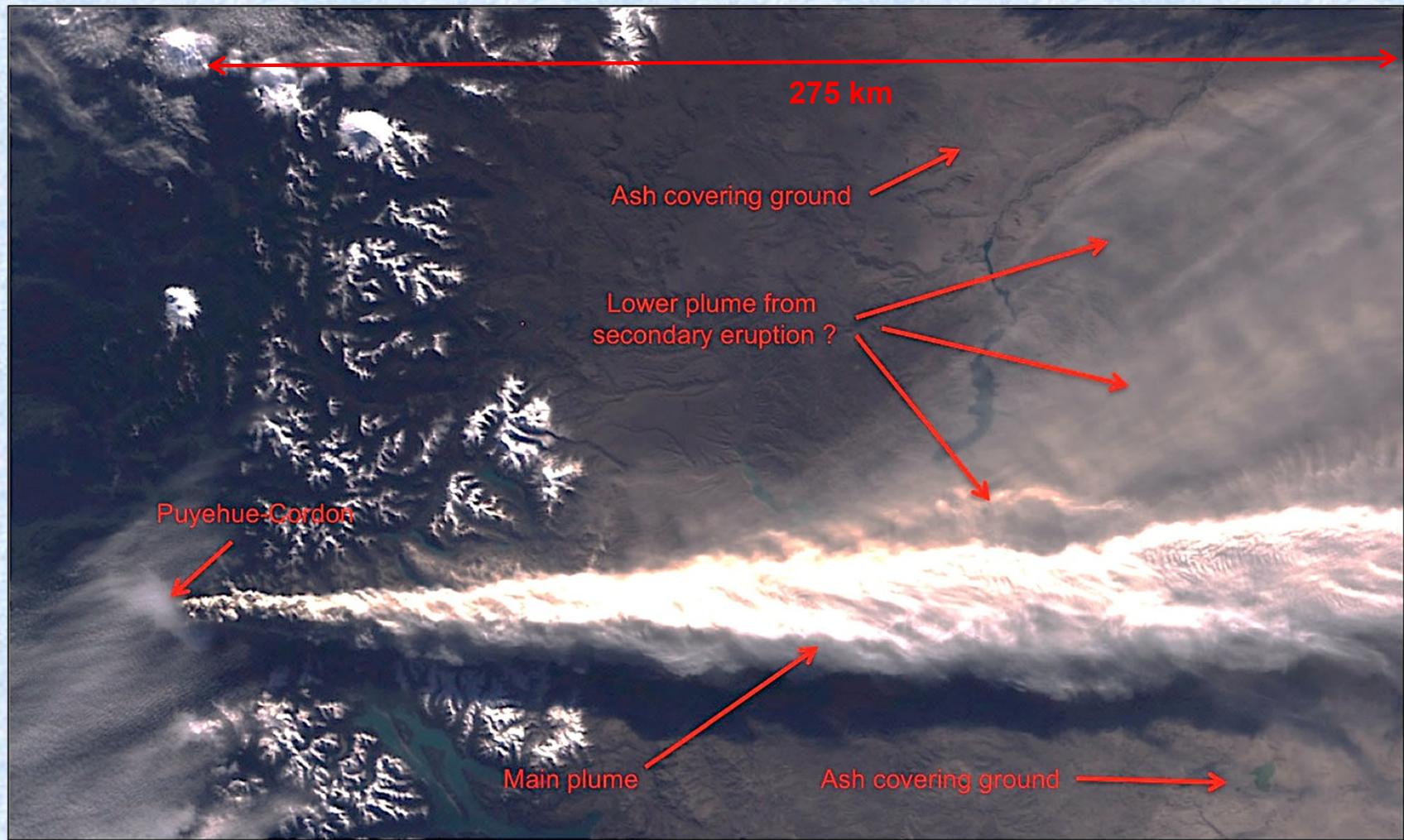
## Puyehue-Cordon Eruption - Animation



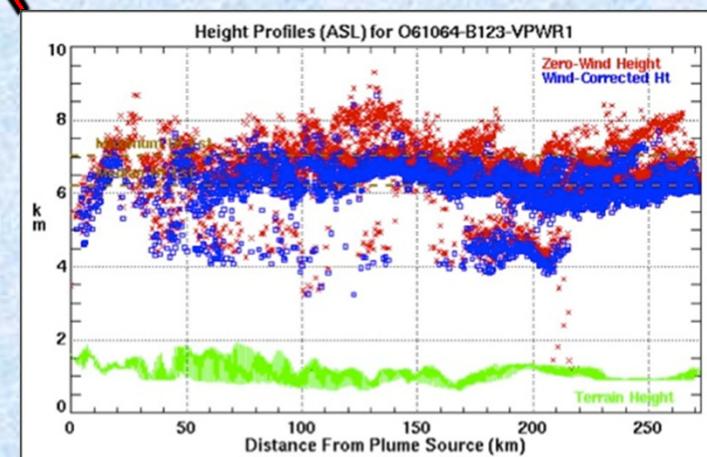
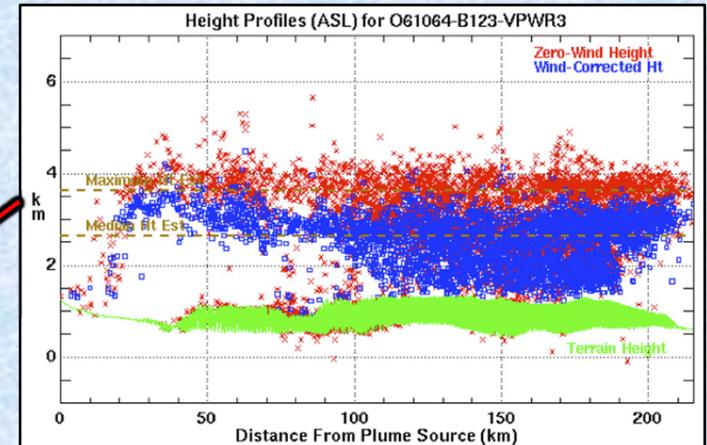
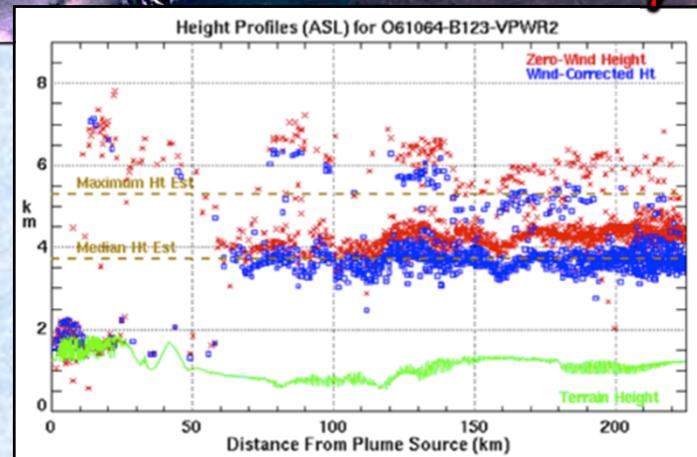
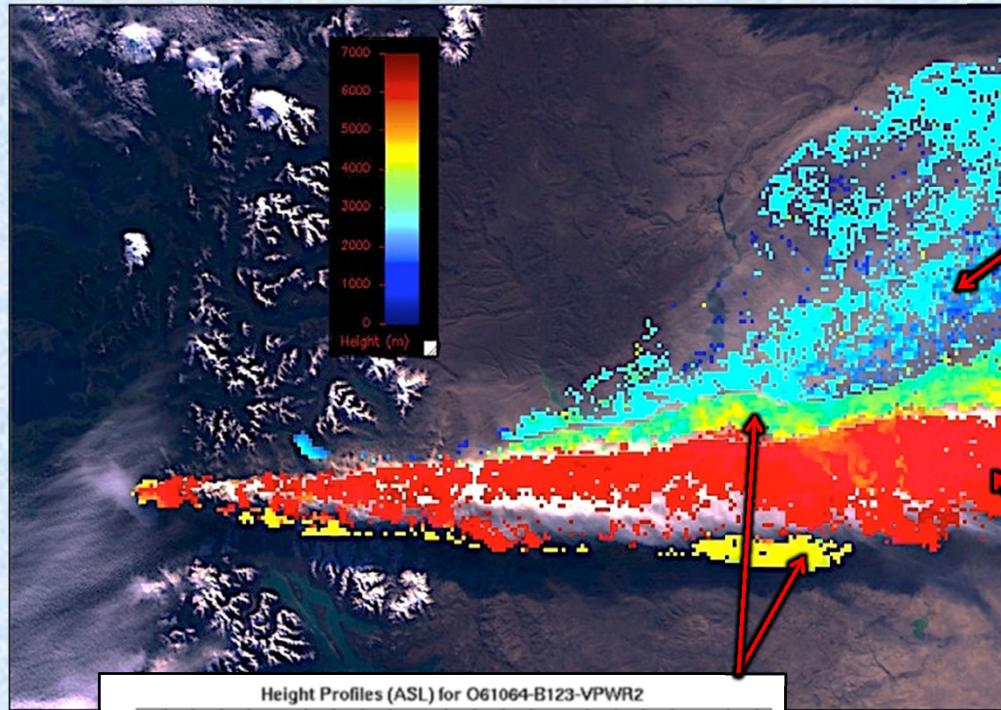
Hover over window then click arrow to start movie

# Puyehue-Cordon Eruption

Orbit 61064 - June 11, 2011



# Puyehue-Cordon – Height Retrievals



# **Contents**

**Scientific motivation for MINX**

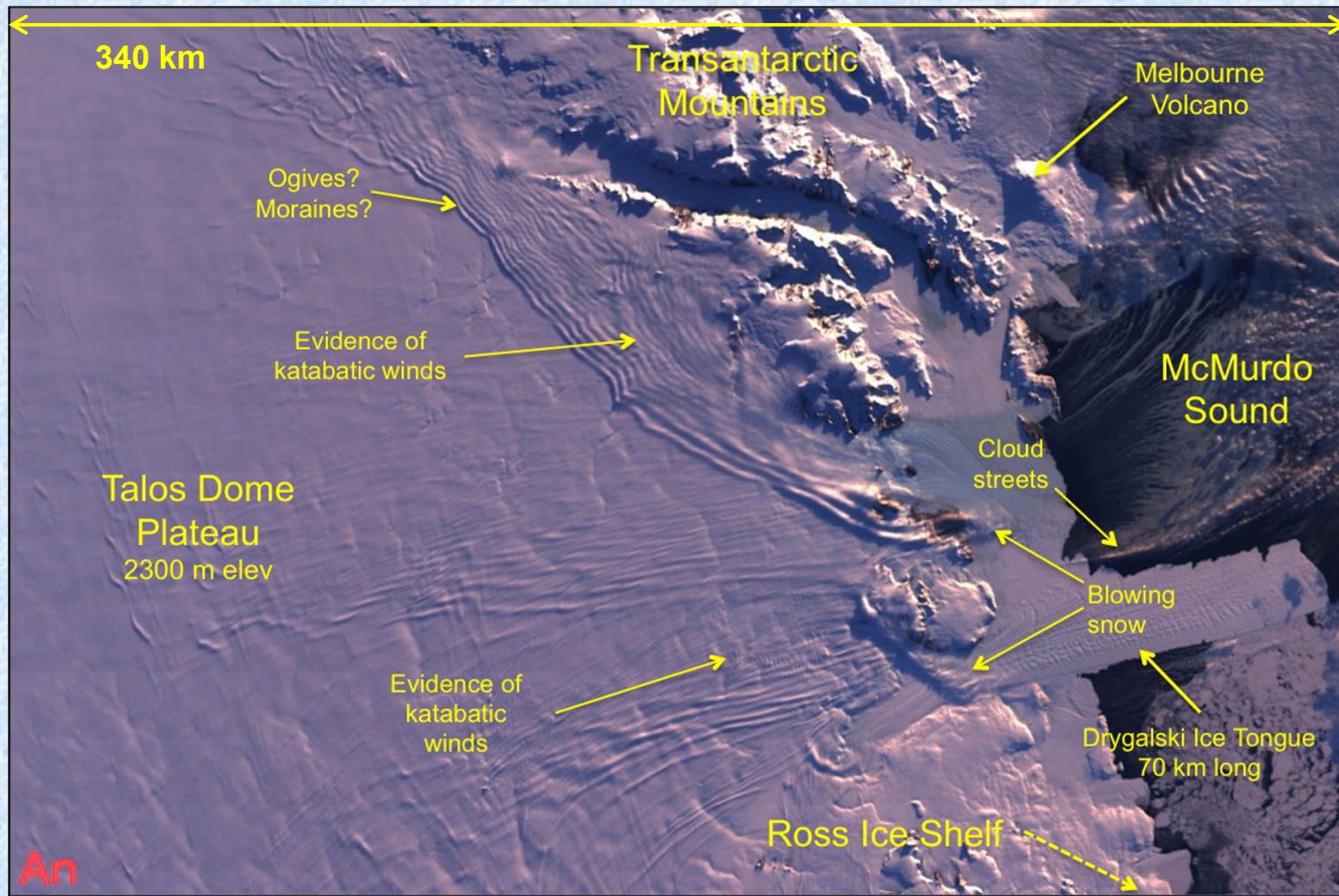
**MISR Plume Project website**

**Animations and interpretations with MINX**

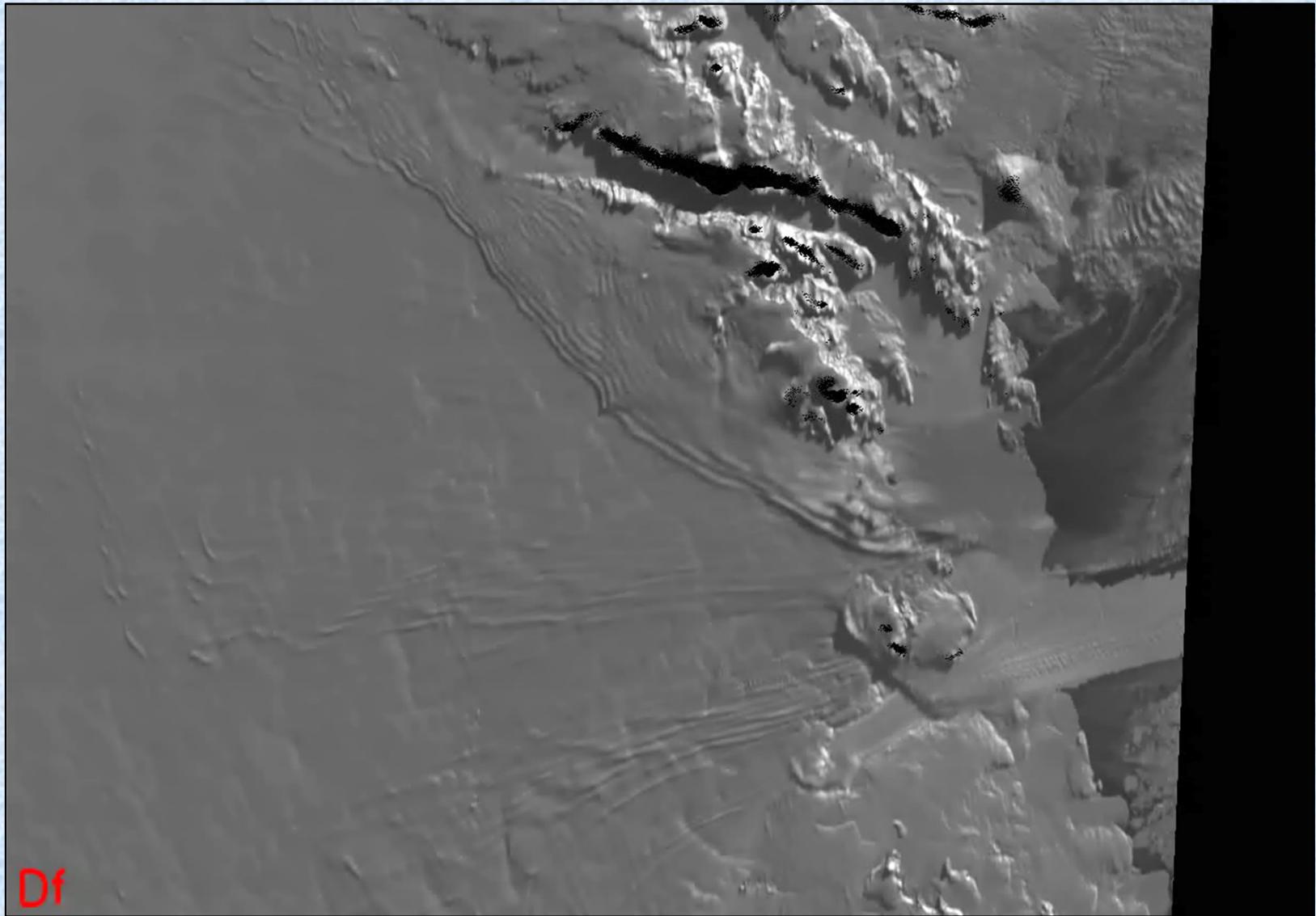
- **Smoke plume over Alaska**
- **Dust in Taklamakan Basin**
- **Volcanic ash over Chile**
- **Snow storm in Antarctica**

# Snow Plumes - Antarctic Blizzard

## Orbit 38671 - March, 2007

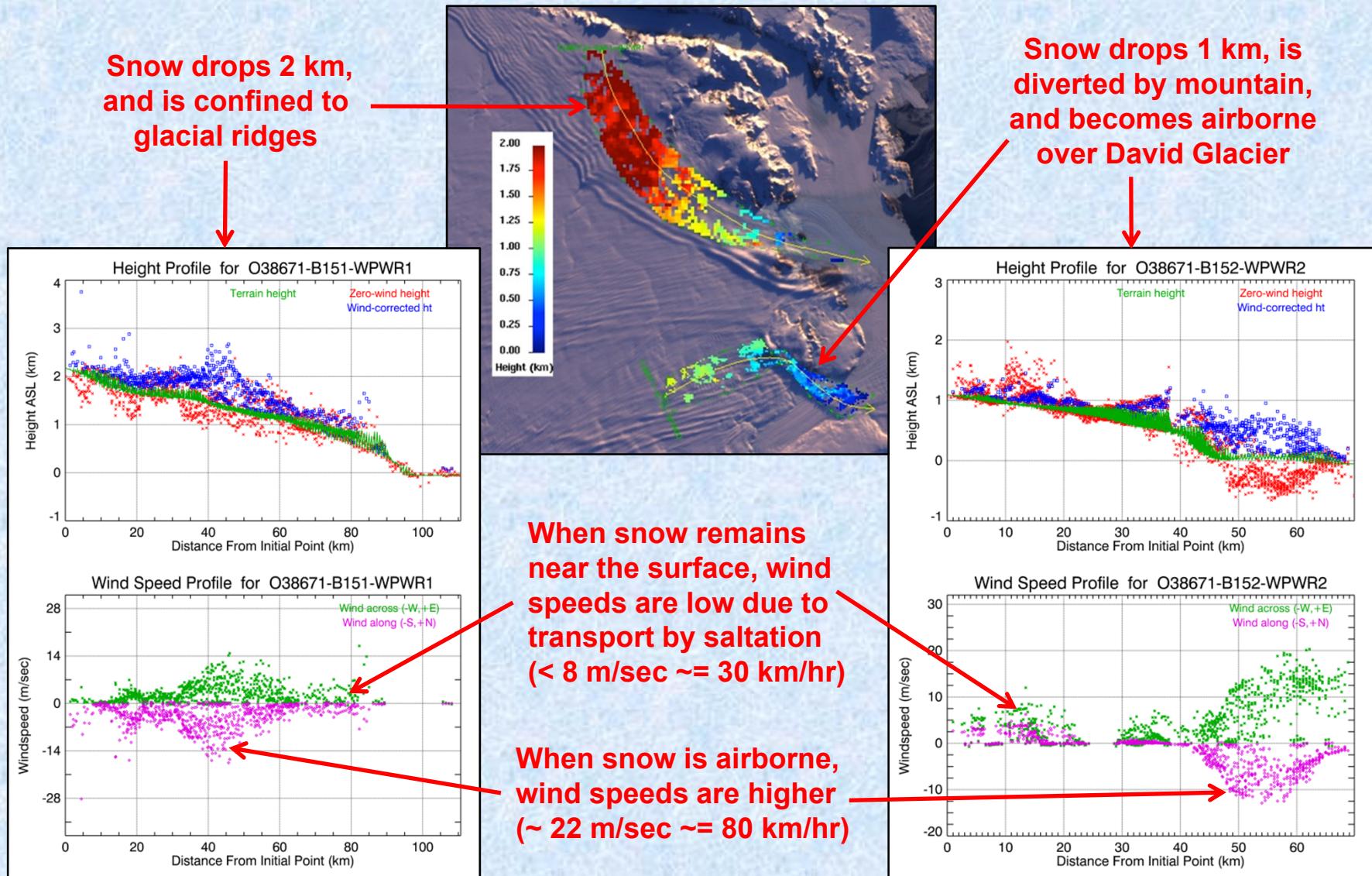


# Antarctic Blizzard – Red-band Animation



Hover over window then click arrow to start movie

# Antarctic Blowing Snow - Height/Wind Retrievals



## References

- Val Martin, M., et al, 2009. "Vertical Transport of Wildfire Smoke over North America: Merging Satellite Observations and Models", presentation to European Geosciences Union.
- MISR Plume Height Project website - <http://www-misr.jpl.nasa.gov/getData/accessData/MisrMinxPlumes/>